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Cells in focus

Pancreatic acinar cell: Its role in acute pancreatitis

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Abstract

The pancreatic acinar cell is the functional unit of the exocrine pancreas. It synthesizes, stores, and secretes digestive enzymes. Under normal physiological conditions, digestive enzymes are activated only once they have reached the duodenum. Premature activation of these enzymes within pancreatic acinar cells leads to the onset of acute pancreatitis; it is the major clinical disorder associated with pancreatic acinar cells. Although there have been major advances in our understanding of the pathogenesis of this disease in recent years, available treatment options are still limited to traditional nonspecific and palliative interventions. Novel therapeutic strategies have been suggested based on ongoing research in the physiology and pathophysiology of the disease; these include the administration of systemic antibiotics, antioxidants, cytokine antagonists, and more recently, inhibition of the renin–angiotensin system. Notwithstanding this promising development, most of these potential therapies are still in an experimental stage or clinical trial. Further investigation is needed to prove the efficacy of these novel treatment modalities.

Cell facts

- The pancreatic acinar cell is the functional unit of the exocrine pancreas which comprises about 80% of the pancreas.
- Pancreatic acinar cells are responsible for the synthesis, storage, and secretion of enzymes for the digestion of our daily foodstuff.
- Pancreatic acinar cells secrete digestive enzymes in response to nutrients, which in turn trigger the neurohormonal pathways that regulate its secretory function.
- The pathophysiology of acute pancreatitis involves dysfunction of pancreatic acinar cells.
- The overall mortality rate of acute pancreatitis is around 10%. However, among severe cases in which the functions of multiple organs are compromised, the mortality rate can reach 20–30%.
- Treatment of acute pancreatitis still rests on traditional methods which are generally palliative and nonspecific; however, novel therapeutic strategies have been proposed such as the administration of systemic antibiotics, antioxidants, cytokine antagonists, and inhibition of the renin–angiotensin system.

Keywords: Renin–angiotensin system; Digestive enzymes; Acute pancreatitis; Exocrine pancreas

1. Introduction

The pancreas has two distinct functional portions: the exocrine and the endocrine pancreas. The endocrine pan-

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creas, consisting of pancreatic islet cells that produce insulin, glucagon, somatostatin, and pancreatic polypeptide serves to maintain the body's glucose homeostasis. The exocrine pancreas is structurally analogous to a bunch of grapes; this architecture contains microscopic, blind-ended tubules that are surrounded by polygonal acinar cells and these tubules are organized into lobules called acini. The primary function of the acini is to synthesize and secrete hydrolytic enzymes which empty into the duodenum for the digestion of our daily foodstuff. Each acinus consists of a small cluster of secretory epithelial cells that form a small central lumen, called intercellular canaliculi. Each acinar cell has a round pyramid-like shape. The acinar cell is highly polarized with two plasma membrane domains. The basolateral membrane is large and located at the acinar periphery; the apical membrane (less than 10% of total surface area of the cell) faces the acinar lumen that connects with a tiny intercalated duct. The digestive enzymes are stored in secretory granules which are concentrated near the apical membrane of the cell. The acini drain into the intercalated ducts, and groups of the intercalated ducts converge into larger intralobular ducts, which in turn drain into much larger extralobular ducts; the latter form a main collecting duct which empties into the duodenum (see Fig. 1). However, the accuracy of the traditional acinar structural model of strictly independent acini has been called into question. There are light and electron microscopy findings, suggesting that the exocrine pancreas may not be organized into true acinar units. Instead, the arrangement may consist of a complexly curving and branching system of tubules which anastomose between adjacent acini (Bockman, 1980).

2. Cell origin and plasticity

Early in the fifth week of intrauterine life in humans, the pancreas arises from the abdominal foregut as dorsal and ventral diverticular buds. The ventral bud rotates to fuse with the dorsal bud which ultimately forms the splenic portion, i.e. body and tail. The ventral duct fuses with the distal portion of the dorsal duct to form the head or duodenal portion of the pancreas.

Some studies have suggested that there is a common pancreatic progenitor which gives rise to both exocrine (acinar) and endocrine (islet) cells, while others have suggested separate endocrine and exocrine lineages. This debate was resolved recently by a pancreatic lineage analysis study using a retroviral vector in embryonic mice which demonstrated that the exocrine and endocrine pancreas come from a common cell origin (Fishman & Melton, 2002). Pancreatic acinar cells appear during the third month of intrauterine life as small clusters of cells along the lateral walls and at the distal ends of the ducts. At the end of third month, glycogen presence can be demonstrated. During the next month of development, the basophilia of the acinar cells increases and small granules with nonspecific esterase activity can be found in the basal cytoplasm. As the size and quantity of the acinar zymogen granules increases, pancreatic acinar cells become capable of secretion during prenatal life (Laitio, Lev, & Orlic, 1974).

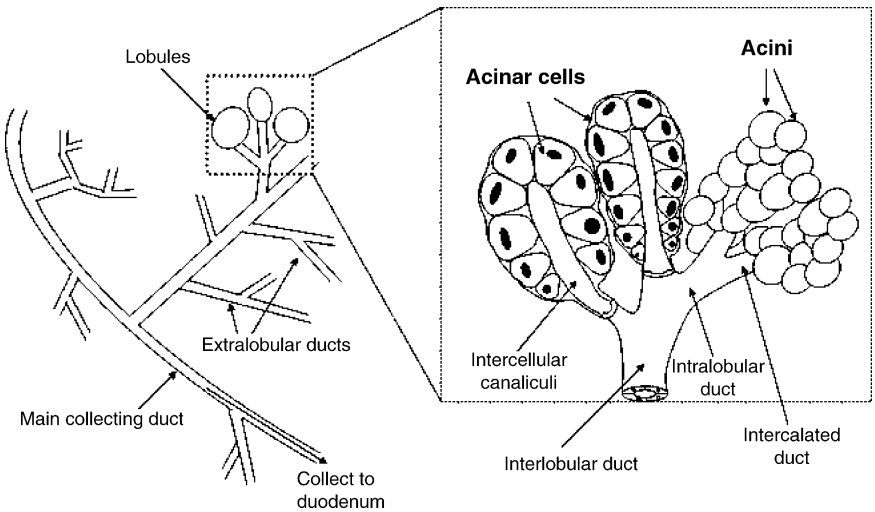

Fig. 1. A schematic representation of the exocrine pancreas. The structure resembles a bunch of grapes and its functional units are the pancreatic acinar cells. Adjacent pyramidal acinar cells are oriented in such a way to form acini, and groups of acini form lobules. Within each lobule, ductules join to form intralobular ducts. These in turn drain into extralobular ducts, which are finally converge into a main collecting duct before connecting with the duodenum.